Stand Persistence, Yields, Quality, and Management of Forages Under Irrigation in Southeast Wyoming

U.S. Department of Agriculture
Science and Education Administration
Agricultural Research Results ● ARR–W–19/February 1981

A copy of this publication is available upon request from the High Plains Grasslands Research Station, 8408 Hildreth Road, Cheyenne, WY 82001.

International Standard Serial Number (ISSN) 0193-3817

Science and Education Administration, Agricultural Research Results, Western Series, No. 19, February 1981

Published by Agricultural Research (Western Region), Science and Education Administration, U.S. Department of Agriculture, Oakland, Calif. 94612

ABSTRACT

Six legumes: 'Dawson', 'Fremont', 'Team', and 'Vernal' alfalfa (*Medicago sativa* L.), 'Lutana' cicer milkvetch (*Astragalus cicer* L.), and 'Remont' sainfoin (*Onobrychis viciifolia* Scop.); eight grasses: 'Latar' orchardgrass (*Dactylis glomerata* L.), 'Fawn' tall fescue (*Festuca arundinacea* Schreb.), 'Regar' bromegrass (*Bromus biebersteinii* Roem & Schult.), 'Manchar' bromegrass (*Bromus inermis* Leyss), 'Garrison' creeping foxtail (*Alopecurus arundinaceus* Poir), meadow foxtail (*A. pratensis* L.), 'Luna' pubescent wheatgrass (*Agropyron trichophorum* (Link) Richt.), and 'Greenar' intermediate wheatgrass (*A. intermedium* (Host) Beauv.); and 14 legume-grass mixtures were evaluated for stand persistence, yield of total dry matter, total digestible nutrients, and crude protein in three management treatments: (1) simulated intensive grazing, (2) simulated moderate grazing, and (3) hay. The alfalfas, Fawn tall fescue, and Latar orchardgrass were the highest producers. Garrison creeping foxtail and Regar bromegrass were stand increasers and resisted weed invasion in the legume-grass mixtures. Growing legume-grass mixtures appeared to stabilize annual yields and quality compared with growing single legumes or grasses. Dawson alfalfa in a mixture with either Garrison creeping foxtail or Regar bromegrass was the most persistent and produced 2 to 3 tons/acre of high quality hay.

KEYWORDS: alfalfa, milkvetch, sainfoin, bromegrass, fescue, foxtail, orchardgrass, wheatgrass, legume-grass mixture, stand persistence, total dry matter, total digestible nutrients, IVDMD inhibiter, crude protein.

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STAND PERSISTENCE, YIELDS, QUALITY, AND MANAGEMENT OF FORAGES UNDER IRRIGATION IN SOUTHEAST WYOMING

By Merle L. Fairbourn and P. G. Brown[1]

INTRODUCTION

Forage research at the High Plains Grasslands Research Station was started in April of 1974. A study was initiated to evaluate available forage species for the production of hay or rotation grazing under irrigation. Since many ranchers have areas that can be irrigated, this approach appeared to be most feasible for increasing forage production. Forage experimental work to determine yields, quality, and seeding practices (*6*, *8*, *12*)[2] indicated potential species for this work. The study was designed to determine stand persistance, yields of total dry matter (TDM), quality in terms of crude protein and total digestible nutrients, harvest management effects, and water-use efficiency of the forage species.

MATERIALS AND METHODS

Six legumes, eight grasses, and 14 legume-grass mixtures were selected for this study. The legumes included 'Dawson', 'Fremont', 'Team', and 'Vernal' alfalfa (*Medicago sativa* L.); 'Lutana' cicer milkvetch (*Astragalus cicer* L.); and 'Remont' sainfoin (*Onobrychis viciifolia* Scop.). The grasses included 'Latar' orchardgrass (*Dactylis glomerata* L.), 'Fawn' tall fescue (*Festuca arundinacea* Schreb.), 'Regar' bromegrass (*Bromus biebersteinii* Roem and Schult.), 'Manchar' bromegrass (*Bromus inermis* Leyss), 'Garrison' creeping foxtail (*Alopecurus arundinaceus* Poir), meadow foxtail (*A. pratensis* L.), 'Luna' pubescent wheatgrass (*Agropyron trichophorum* (Link) Richt.) and 'Greenar' intermediate wheatgrass (*A. intermedium* (Host) Beauv.). The legume-grass mixtures included combinations of Dawson alfalfa with Latar orchardgrass, Regar bromegrass, and Garrison creeping foxtail; Lutana cicer milkvetch with the same three grasses; and Team alfalfa with Garrison creeping foxtail or Regar bromegrass.

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[2]Italic numbers in parentheses refer to Literature Cited, p. 17.

The study was conducted on Archerson fine, sandy, clay loam, one of the extensive soil types of southeast Wyoming, western Nebraska, and northern Colorado. This soil is a member of the mixed mesic family of Aridic Arguistols (*14*).

The experimental design was a year by species or mixture by harvest treatment split split plot with two replications. Each species or mixture was planted in strips 8 ft wide and 235 ft long. The three harvest treatments were (1) simulated intensive grazing, (2) simulated moderate grazing, and (3) hay production. These treatments were randomly located on the strips of forage in 8- by 16-ft plots.

The experimental area was plowed, disked, harrowed, and rolled in late April 1974 to prepare a firm seedbed before planting. The forages were drill planted May 2 through 6 at the following rates per acre: legumes (12 lb), grasses (10 lb), and mixtures of one legume (6 lb) plus one grass (5 lb), of one legume (4 lb) plus two grasses (4 lb each), and of one legume (4 lb) plus three grasses (3 lb each). All legumes were treated with appropriate inoculants before planting.

Fertilizer was broadcast ahead of planting, and rates applied were 43 lb P/acre as P_2O_5 on legumes, 67 lb N/acre as NH_4NO_3 on grasses, and 22 lb P/acre as P_2O_5 on the mixtures. During years following seedling establishment, fertilizer was broadcast on the grasses at the rate of 67 lb N/acre as NH_4NO_3 in May and July of each year. In the spring of 1975, 14 lb N/acre as $(NH_4)_2SO_3$ was broadcast on the mixtures.

All forages were irrigated with an overhead sprinkler, and approximately 0.8 inch of water was applied each 3 to 4 days during the growing season (May 15 through Sept. 15).

Stand counts of the forages were made each spring and fall. The forages were planted in rows 8 inches apart and were considered to be a full stand if vacant areas within a row were less than 4 inches in length. Four marked observation rows with a combined total length of 66 ft 8 inches (100 8-inch sections) were established in each plot. Percent stand was determined by counting the number of 4-inch spaces without plants in the marked rows, multiplying the number by 0.5, and deducting the product from 100.

Six or seven harvests per year were made on the simulated grazing treatments, whereas three harvests per year were made on the hay production treatment. The simulated grazing treatments were cut to 2-inch and 4-inch stubble heights every 2 weeks on intensive and moderate grazing, respectively. Harvests were made with a rotary mower, which bagged the forage as it was cut. Plot yields were determined from a randomly selected 2- by 16-ft swath, and the green forage was ovendried at 65°C to determine TDM. The hay treatment legumes were harvested when they were at 25 percent bloom, whereas grasses were harvested each year at the boot or heading stage on the first harvest and when they were at 10 to 15 inches tall on succeeding harvests. Entire plot areas were cut with the rotary mower on the hay treatment, and the fresh weight of the forage was measured. Subsamples were obtained, weighed, and ovendried to determine TDM yields.

Crude protein and in vitro dry matter digestability (IVDMD) were determined on all forages. Crude protein was obtained by analyzing the forage for total N by an automated method (*9*) and by multiplying the percent N by the factor of 6.25. IVDMD was determined by modification of a method described by Tilley and Terry (*10*). All TDM, crude protein, and IVDMD values were statistically analyzed by analysis of variance to determine the interaction of years, species, and harvests. Means were ranked by Duncan's multiple range test.

RESULTS AND DISCUSSION

Emergence of the different species or cultivars occurred from 7 to 24 days after planting as follows:

Species or cultivar	*Days from planting to emergence*
Dawson alfalfa	7
Latar orchardgrass	10
Vernal alfalfa	12
Fawn tall fescue	12
Fremont alfalfa	13
Team alfalfa	13
Luna pubescent wheatgrass	13
Manchar bromegrass	13
Regar bromegrass	13
Greenar intermediate wheatgrass	14
Lutana cicer milkvetch	20
Meadow foxtail	20
Remont sainfoin	24
Garrison creeping foxtail	24

Percentage seedling emergence and establishment were generally rated good for all species except Lutana cicer milkvetch, Remont sainfoin, meadow foxtail, and Garrison creeping foxtail. A higher seeding rate or research to determine better seeding techniques may have been necessary for the two legume species. Sainfoin may have been slow to germinate because of less than optimum soil temperatures (*3*).

Garrison creeping foxtail and meadow foxtail were very slow in emergence and seedling establishment. The decision was made to fallow the strips of these two species and replant them in 1975. The light, fluffy seed would not pass through the drill evenly and was very difficult to sow at a uniform rate; however, experience with the grasses during the study indicated that once they were sown, stand establishment was adequate if given time. The new seedlings were hard to identify, but they survived and made significant growth during the growing season following the seeding year.

Percentage of stand for representative species of the legumes and grass is given in figures 1 and 2. All the alfalfa cultivars were similar to Dawson in percentage of stand until the spring of 1978. At that time, Dawson had an average stand of 75 percent compared with 55 percent for the other alfalfa cultivars. The legumes remained in well-defined rows from season to season except

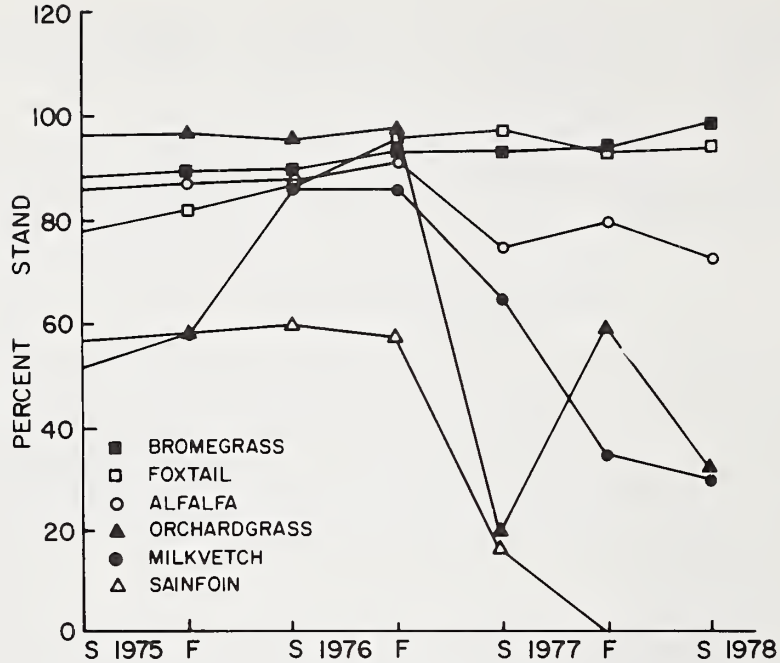

Figure 1.--Percent stand in the hay treatment of Dawson alfalfa, Lutana cicer milkvetch, Remont sainfoin, Garrison creeping foxtail, Latar orchardgrass, and Regar bromegrass from the spring of 1975 through the spring of 1978 at the High Plains Grasslands Research Station, Cheyenne, Wyo.

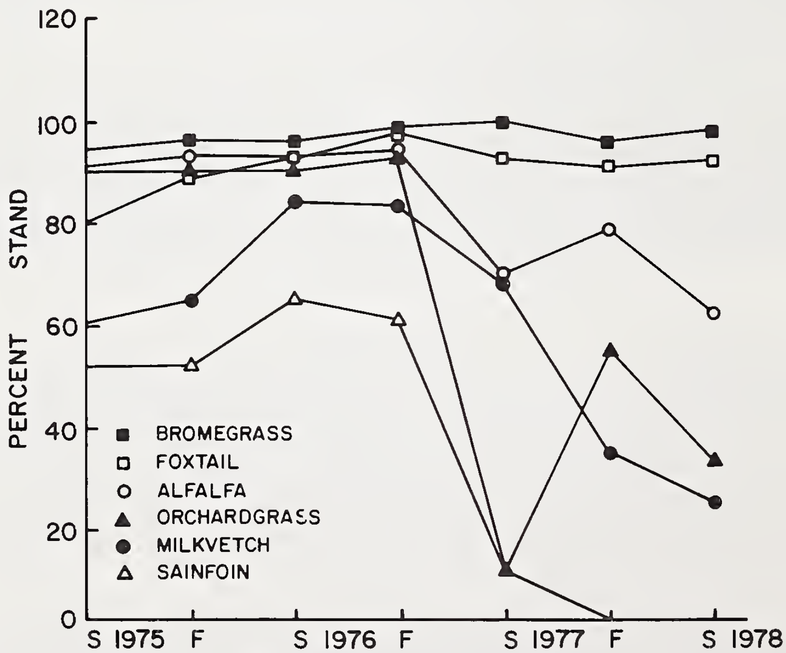

Figure 2.--Percent stand in the simulated intensive grazing treatment of Dawson alfalfa, Lutana cicer milkvetch, Remont sainfoin, Garrison creeping foxtail, Latar orchardgrass, and Regar bromegrass from the spring of 1975 through the spring of 1978 at the High Plains Grasslands Research Station, Cheyenne, Wyo.

for the rhizomatous milkvetch. This species increased toward continuous ground cover until the spring of 1977. The reduced stands of alfalfa, milkvetch, sainfoin, and orchardgrass at that time were caused by an open dry winter when many plants winterkilled. The winter of 1976-77 had below normal precipitation and humidity, above normal temperatures, and windspeeds ranged from 30 to 48 miles per hour on some days *(13)*. The indicated stand increase on figures 1 and 2 for the fall of 1977 on Dawson alfalfa and Latar orchardgrass was probably because some of the suspected dead plants put forth buds or tillers late in the spring and produced forage in 1977.

Morphology plays an important role in species adaptability. The crown of orchardgrass is above the soil surface and is more vulnerable to desiccation, temperature extremes, and other environmental factors than the other grasses used in this study. These other grasses had new tillers arising at nodes below the soil surface. Some of the species had rhizomes and developed a continuous ground cover as indicated by the data of figures 1 and 2 for Garrison creeping foxtail and Regar bromegrass.

The strong rhizomatous feature of Garrison creeping foxtail and Regar bromegrass gave them a distinct advantage in the mixtures (figs. 3 to 7).

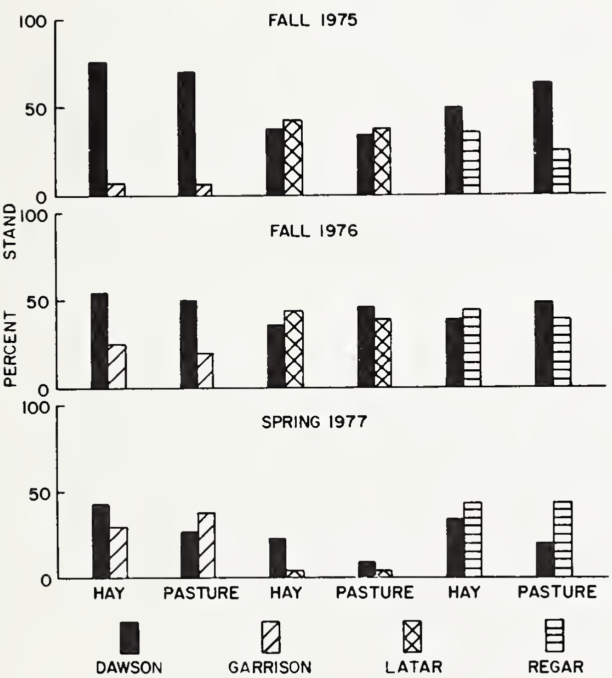

Figure 3.--Percent stand in mixtures of Dawson alfalfa with a single grass species, Garrison creeping foxtail, Latar orchardgrass, or Regar bromegrass, from the fall of 1975 through the spring of 1977 at the High Plains Grasslands Research Station, Cheyenne, Wyo.

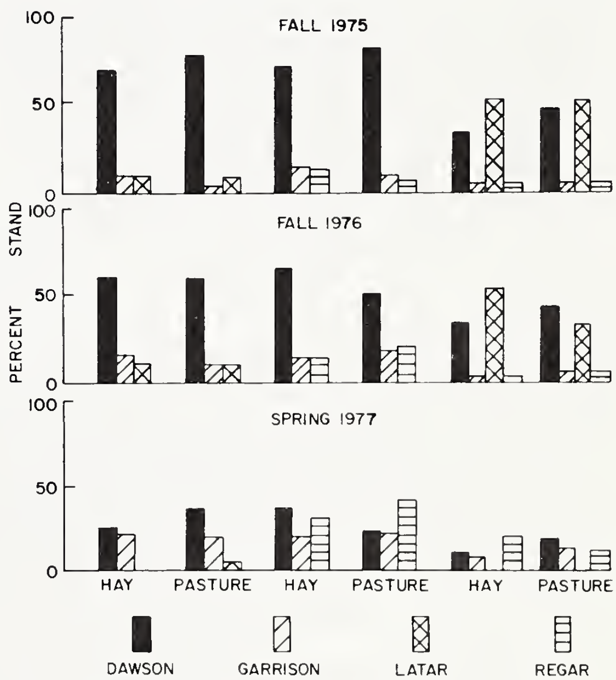

Figure 4.--Percent stand in mixture on Dawson alfalfa with either two or three grass species, Garrison creeping foxtail, Latar orchardgrass, and Regar bromegrass, from the fall of 1975 through the spring of 1977 at the High Plains Grasslands Research Station, Cheyenne, Wyo.

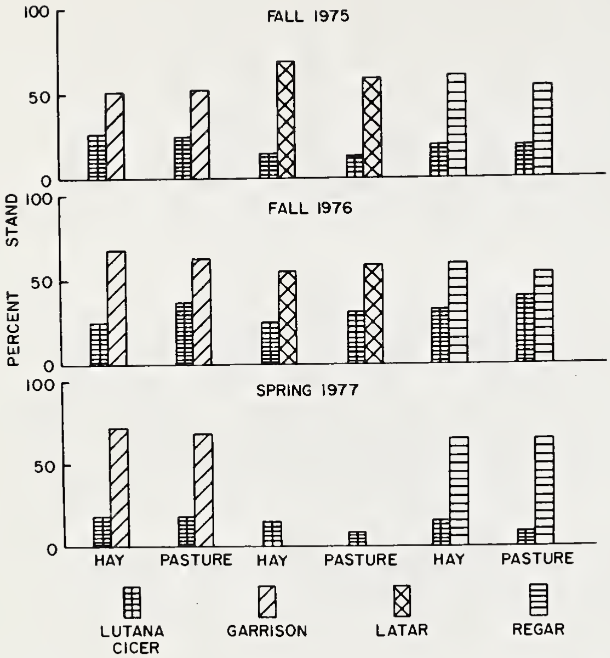

Figure 5.--Percent stand in mixtures of Lutana cicer milkvetch with a single grass species, Garrison creeping foxtail, Latar orchardgrass, or Regar bromegrass, from the fall of 1975 through the spring of 1977 at the High Plains Grasslands Research Station, Cheyenne, Wyo.

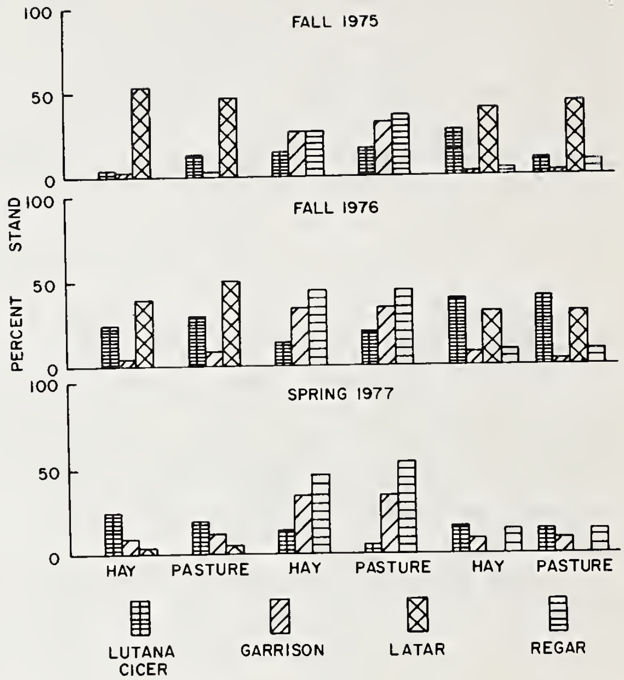

Figure 6.--Percent stand in mixtures of Lutana cicer milkvetch with either two or three grass species, Garrison creeping foxtail, Latar orchardgrass, and Regar bromegrass from the fall of 1975 through the spring of 1977 at the High Plains Grasslands Research Station, Cheyenne, Wyo.

These grasses were stand increasers, and they resisted invasion by plants foreign to the seeding mixture. This was a greater advantage for the forages in mixtures than for the single legume plantings. The mixtures have been productive for five growing seasons, whereas the legumes were invaded by weeds and had to be plowed up at the beginning of the fourth season. The two wheatgrasses and Manchar bromegrass were also rhizomatous and developed a continuous sod cover. Fawn tall fescue and meadow foxtail differed in that they were bunch-type grasses. The fescue developed broad crowns, which practically made a continuous ground cover. Meadow foxtail remained in rows throughout the study.

The grass cover in the mixtures appeared to reduce winter desiccation. This observation was supported by the milkvetch treatments, which generally had a higher survival rate when grown in a mixture with grass. Apparently, the microclimate is enhanced by the grass.

A comparison of the hay and simulated grazing treatments in the legume-grass mixtures shows that the legumes generally had a lower survival rate under simulated grazing by the 1977 season. Biweekly harvests depleted plant root reserves more than the hay treatment. The loss of legumes would probably have been greater if the simulated grazing treatments had been selectively grazed and trampled by animals (*1*).

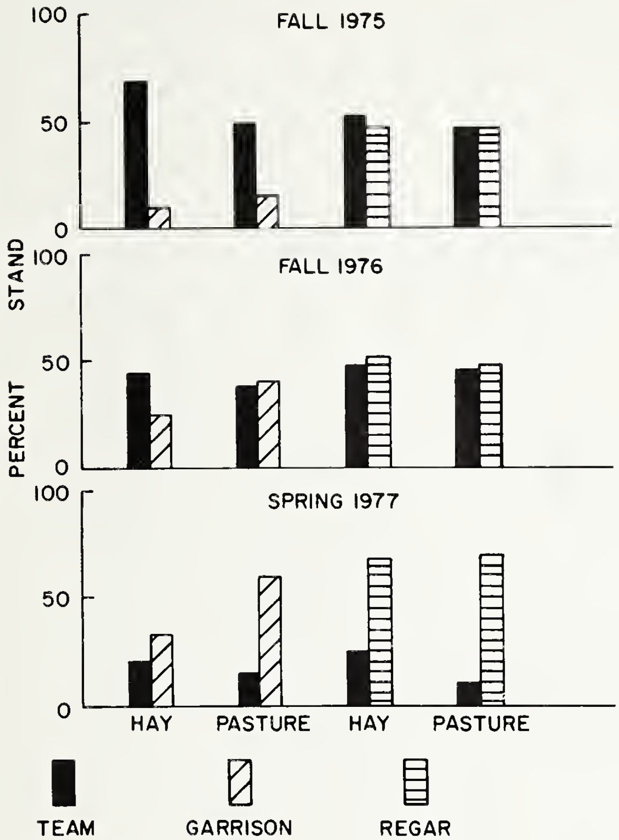

Figure 7.--Percent stand in mixtures of Team alfalfa with a single grass species, Garrison creeping foxtail, or Regar bromegrass, from the fall of 1975 through the spring of 1977 at the High Plains Grasslands Research Station, Cheyenne, Wyo.

The average TDM and crude protein yields on the hay treatments were generally greater than for the simulated pasture treatments (tables 1 to 3). This appeared to be a response to harvest frequency. There was less interrupted growing time due to harvests in the production of hay than in the simulated grazing. Neither of the simulated grazing treatments showed a consistant advantage for one over the other. Individual species or cultivars such as the alfalfas, Fawn tall fescue, and Latar orchardgrass were consistantly the highest producers. Greenar intermediate wheatgrass made relatively high hay yields. This species was always the last of the grasses to head and made its greatest hay yields on the first crop. While grasses such as Garrison creeping foxtail, meadow foxtail, and Regar bromegrass did not produce the highest yields, they distinguished themselves as consistent and persistant forage producers as indicated above.

The alfalfa-grass mixtures produced greater yields than the milkvetch grass mixtures (table 3). This appeared to be due in part to a fertility response during the first 2 years of the study. The general appearance of the forages indicated that the alfalfa-grass mixtures had a better balance of nutrients than the milkvetch-grass mixtures. Apparently, less time is needed for symbiotic produced NO_3 to become available to the grass-alfalfa mixtures than to the grass-milkvetch mixtures.

The regrowth potential of the different species is illustrated in figure 8. These 1976 data were presented because that was the only year in which all forage species of this study were in production. The data are representative

Table 1.--*Average annual yields*[1] *of total dry matter (TDM) and crude protein from simulated grazing and hay treatments on legumes from 1975 through 1977 at the High Plains Grasslands Research Station*

	Simulated					
	Intensive grazing		Moderate grazing		Hay	
Species or cultivar	TDM	Protein	TDM	Protein	TDM	Protein
	Tons/acre					
Dawson alfalfa	1.15 de	0.30 de	1.23 de	0.34 d	2.49 b	0.50 bc
Fremont alfalfa	1.13 de	.29 de	1.05 def	.26 ef	2.13 c	.44 c
L.C. milkvetch	.84 fg	.22 fg	.69 g	.18 g	1.02 ef	.19 g
Team alfalfa	1.15 de	.28 de	1.22 de	.32 de	2.46 b	.51 b
Vernal alfalfa	1.32 d	.35 d	1.30 d	.34 d	3.06 a	.62 a
Remont sainfoin[2]	.41	.11	.48	.11	.85	.14

[1]Values followed by the same letter for either TDM or crude protein yields are not significantly different at the 5-percent level.
[2]Data are for only 2 years and were not statistically analyzed.

Table 2.--*Average annual yields*[1] *of total dry matter (TDM) and crude protein from simulated grazing and hay treatments on grasses from 1975 through 1977 at the High Plains Grasslands Research Station*

	Simulated					
	Intensive grazing		Moderate grazing		Hay	
Species	TDM	Protein	TDM	Protein	TDM	Protein
	Tons/acre					
Fawn tall fescue	1.81 c	0.33 bc	1.48 de	0.27 def	3.03 a	0.46 a
Greenar Int. W.G.	.96 fg	.20 ghi	.97 fg	.19 ghi	2.30 b	.35 b
Luna Pub. W.G.	1.15 ef	.24 efg	.76 g	.15 i	1.40 de	.22 fgh
Manchar bromegrass	.80 g	.19 hi	.80 g	.18 hi	1.70 ed	.32 bcd
Regar bromegrass	1.17 ef	.23 e-h	1.17 ef	.22 fgh	1.84 c	.28 cde
Garrison creeping foxtail.[2]	1.00	.19	.72	.26	1.61	.19
Latar orchardgrass[2]	1.52	.37	1.81	.35	2.29	.37
Meadow foxtail[2]	2.01	.20	.86	.17	1.94	.23

[1]Values followed by the same letter for either TDM or crude protein yields are not significantly different at the 5-percent level.

[2]Data are for only 2 years and were not statistically analyzed.

Table 3.--*Average annual yields*[1] *of total dry matter (TDM) and crude protein from simulated grazing and hay treatments on legume-grass mixtures from 1975 through 1977 at the High Plains Grasslands Research Station*

Mixture	Simulated				Hay	
	Intensive grazing		Moderate grazing			
	TDM	Protein	TDM	Protein	TDM	Protein
	Tons/acre					
Dawson + Garrison	0.92 f-l	0.27 c	0.93 f-l	0.25 c	1.66 d	0.36 b
Dawson + Latar	.92 f-l	.22 cde	1.00 e-i	.23 cd	2.08 bc	.36 b
Dawson + Regar	1.05 e-h	.26 c	1.06 e-h	.25 c	2.35 b	.47 a
Dawson + Garrison + Latar	.99 e-j	.24 c	.96 f-k	.24 c	1.81 cd	.31 b
Dawson + Garrison + Regar	1.12 efg	.26 c	1.05 e-h	.24 c	2.67 a	.51 a
Dawson + Garrison + Latar + Regar	.76 h-n	.16 f-k	.96 f-k	.21 c-g	1.86 cd	.32 b
Milkvetch + Garrison	.96 f-k	.21 c-f	.71 h-n	.16 f-k	1.31 e	.24 c
Milkvetch + Latar	.56 mn	.13 i-l	.60 lmn	.13 i-l	.74 h-n	.13 i-l
Milkvetch + Regar	.49 n	.09 kl	.63 k-n	.13 i-l	.78 g-n	.13 i-l
Milkvetch + Garrison + Latar	.50 n	.11 i-l	.45 n	.10 jkl	.47 n	.08 l
Milkvetch + Garrison + Regar	.77 g-n	.13 i-l	.67 i-n	.13 i-l	.93 f-l	.15 h-k
Milkvetch + Garrison + Latar + Regar	.64 j-n	.14 h-l	.63 k-n	.15 g-k	.88 f-m	.16 e-j
Team + Garrison	.85 h-m	.21 c-g	.75 h-n	.17 d-i	1.89 cd	.37 b
Team + Regar	1.21 ef	.25 c	1.04 e-h	.20 c-h	2.08 bc	.37 b

[1]Values followed by the same letter for either TDM or crude protein yields are not significantly different at the 5-percent level.

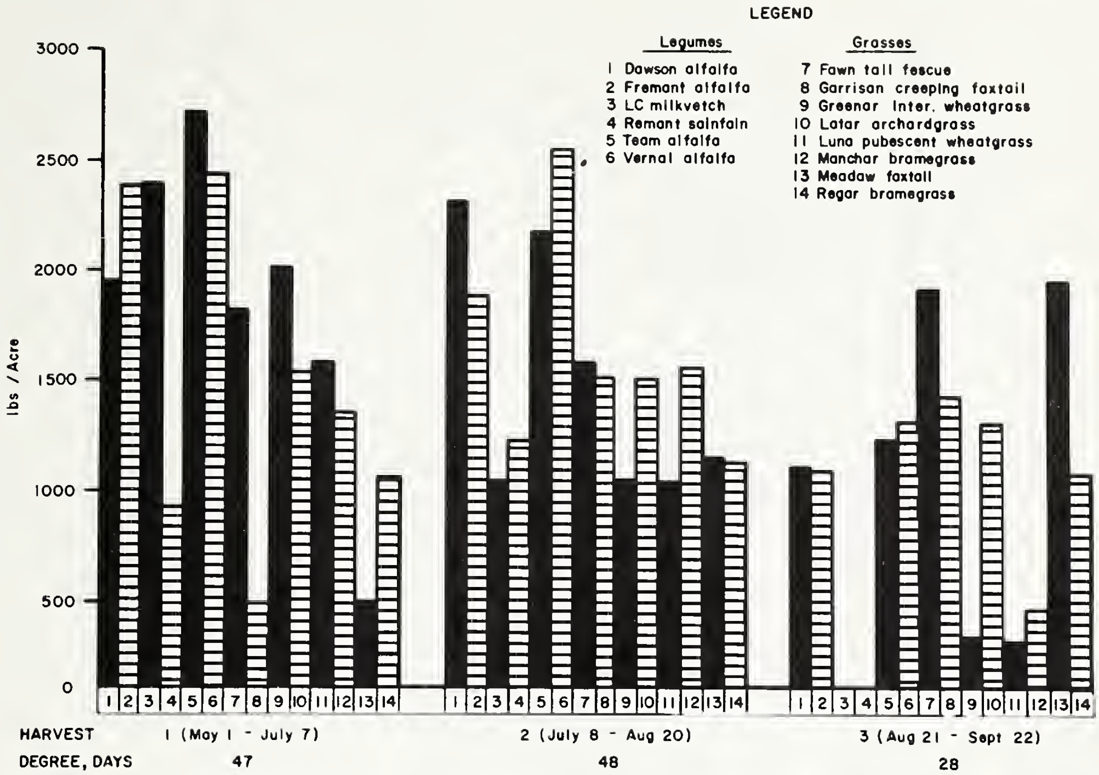

Figure 8.--Hay production by harvests during 1976 for six legumes and eight grasses with adjusted degree days *(4)*.

for the relative differences in hay production by the different species except for the milkvetch and sainfoin in the third harvest. These species produced a third crop in 1975 and the milkvetch produced one in 1977. The response of these species appeared to be due to temperature, which will be discussed later.

Quality in percent crude protein and IVDMD was shown for only the hay treatments (tables 4 to 6). The simulated grazing treatments were harvested when the forage was relatively immature and succulent, containing a higher percent crude protein and IVDMD than the hay treatment. The hay quality was similar from year to year for all the legumes except the 1976 milkvetch. Growing legume-grass mixtures appeared to stabilize the annual percent crude protein and IVDMD of the forages; however, all the grass hays harvested in 1976 showed a decrease in protein level, whereas Fawn tall fescue, Manchar bromegrass, and Regar bromegrass showed reduced IVDMD.

The IVDMD of Fawn tall fescue and Manchar bromegrass for the second and third harvests and for Regar bromegrass in the third harvest was low in 1976, ranging from 33 to 48 percent. Research has shown that the alkaloid perloline inhibits IVDMD (*2*). The inhibited IVDMD's of the 1976 harvests of fescue and brome were correlated with identifiable perloline (5). Nollar and Rhykerd (7) have cited research which shows that concentration of alkaloids is influenced by temperature, light intensity, and NO_3-N. They also reported that high levels of perloline were associated with N fertilization in fescue and ryegrass. A survey of Cheyenne temperature data (*13*) indicates that 1976 thermal units differed significantly from those of 1975 or 1977 (table 7).

Table 4.--*Average percent protein and in vitro dry matter digestability (IVDMD)*[1] *for the legume hay treatments from 1975 through 1977 at Cheyenne, Wyo.*

Species or cultivar	1975		1976		1977	
	Protein	IVDMD	Protein	IVDMD	Protein	IVDMD
	Percent					
Dawson alfafla	19.8 cd	65.0 cd	21.0 b	69.6 a	19.4 d	64.7 d
Fremont alfalfa	19.8 cd	65.6 bcd	22.2 a	67.9 a-d	20.3 bc	67.8 a-d
L.C. milkvetch	20.7 b	68.1 abc	19.4 d	60.5 e	20.7 b	67.6 a-d
Team alfalfa	20.8 b	66.9 a-d	20.9 b	68.5 ab	19.7 cd	66.6 a-d
Vernal alfalfa	20.6 b	65.0 cd	21.0 b	66.8 a-d	19.6 cd	65.2 bcd
Remont sainfoin[2]	17.8	61.8	17.5	60.0	--	--

[1]Values followed by the same letter for either percent protein or IVDMD are not significantly different at the 5-percent level.

[2]Data are for only 2 years and were not statistically analyzed.

Note: Dashes indicate no data.

Table 5.--*Average percent protein and in vitro dry matter digestability (IVDMD)*[1] *for the grass hay treatments from 1975 through 1977 at Cheyenne, Wyo.*

Species	1975		1976		1977	
	Protein	IVDMD	Protein	IVDMD	Protein	IVDMD
	Percent					
Fawn tall fescue	16.4 cde	59.1 e	13.5 g	45.8 g	15.4 def	63.9 b-e
Greenar intermediate wheatgrass	18.4 b	60.6 de	14.7 fg	63.4 b-e	19.1 b	67.7 abc
Luna pubescent wheatgrass	16.8 cd	62.2 cde	13.4 g	83.8 b-e	18.7 b	70.0 a
Manchar bromegrass	18.6 b	59.5 e	17.0 c	51.6 f	21.3 a	68.1 ab
Regar bromegrass	15.2 ef	62.6 b-e	14.2 fg	53.2 f	16.8 cd	66.2 a-d
Garrison creeping foxtail[2]	--	--	14.7	64.0	18.3	69.4
Latar orchardgrass[2]	16.8	61.5	13.5	64.6	--	--
Meadow foxtail[2]	--	--	16.4	59.0	19.4	64.0

[1]Values followed by the same letter for either percent protein or IVDMD are not significantly different at the 5-percent level.

[2]Data are for only 2 years and were not statistically analyzed.

Note: Dashes indicate no data.

Table 6.--*Average percent protein in vitro dry matter digestability (IVDMD)*[1] *for the legume-grass mixture hay treatments from 1975 through 1977 at Cheyenne, Wyo.*

Mixture	1975 Protein	1975 IVDMD	1976 Protein	1976 IVDMD	1977 Protein	1977 IVDMD
	Percent					
Dawson + Garrison	18.8 f-j	69.4 a-d	20.7 b-f	69.6 a-d	20.8 b-e	66.3 a-e
Dawson + Latar	15.8 n-s	70.5 abc	17.3 j-p	69.8 a-d	21.3 bcd	68.9 a-d
Dawson + Regar	19.3 e-i	69.0 a-d	18.1 h-l	68.3 a-e	19.5 c-h	67.9 a-e
Dawson + Garrison + Latar	18.5 g-k	68.6 a-e	19.4 d-i	68.3 a-e	21.8 ab	70.2 abc
Dawson + Garrison + Regar	19.2 e-j	65.8 b-e	19.4 d-i	67.6 a-e	20.1 b-g	69.3 a-d
Dawson + Garrison + Latar + Regar	16.1 m-r	70.5 abc	16.8 k-q	68.2 a-e	20.6 b-f	71.1 a
Milkvetch + Garrison	18.3 g-l	69.9 a-e	19.5 c-h	66.3 a-e	20.9 b-e	63.6 e
Milkvetch + Latar	15.3 qrs	70.0 a-d	16.4 l-r	69.9 a-d	23.3 a	70.8 ab
Milkvetch + Regar	14.0 st	65.4 cde	16.6 k-q	67.1 a-e	17.7 h-n	66.6 a-e
Milkvetch + Garrison + Latar	13.3 t	66.2 a-e	14.6 rst	66.4 a-e	21.0 b-e	68.5 a-e
Milkvetch + Garrison + Regar	15.4 o-s	66.8 a-e	15.8 n-s	69.1 a-d	17.6 h-n	68.2 a-e
Milkvetch + Garrison + Latar + Regar	15.4 o-s	67.7 a-e	18.1 h-l	68.0 a-e	21.4 bc	64.9 de
Team + Garrison	18.0 h-n	66.1 a-e	19.3 e-i	69.8 a-d	20.8 b-e	69.4 a-d
Team + Regar	17.5 o-s	68.8 a-d	17.3 j-o	69.7 a-d	17.7 h-n	68.3 a-e

[1] Values followed by the same letter for either percent protein or IVDMD are not significantly different at the 5-percent level.

Table 7.--*Adjusted degree days*[1] *with harvest growing periods during 1975 through 1977 at Cheyenne, Wyo.*

Year	First Harvest		Second Harvest		Third Harvest		Total degree days
	Growing period	Degree days	Growing period	Degree days	Growing period	Degree days	
1975	5/1-6/24	29	6/25- 8/6	46	8/7 -9/16	38	113
1976	5/1- 7/7	47	7/8 -8/20	48	8/21-9/22	28	123
1977	5/1-6/21	38	6/22-7/29	42	7/30-8/31	31	111

[1]Temperatures below 5°C were counted as 5°; temperatures above 30° were counted as 30° (*4*).

Although the total degree days was greater for the 1976 growing season than for that of 1975 and 1977, this was probably not the major factor that influenced the percent protein and IVDMD of the milkvetch and grasses. The distribution of days 30°C or above appeared to have the greatest influence. Unlike the first harvest periods of 1975 and 1977, 1976 had 4 days when temperatures exceeded 30°. The second harvest period followed with 11 days above 30°, and 8 of them were in succession. The second periods of 1975 and 1977 had 4 days and 1 day respectively, above 30°, and these were not in succession. Apparently, the high temperatures of 1976 initiate rank growth in the first and second harvests of milkvetch, which were not as high in protein because of dilution as forage produced in 1975 or 1977. The third harvest period of 1976 was 2 to 3 weeks later than the third growing period of 1975 or 1977. Temperatures of the 1976 third growing period appeared to have dropped too low to initiate milkvetch or sainfoin regrowth. High 1976 temperatures appeared to be the factor that initiated alkaloid synthesis in the fescue and bromegrasses and may also have indirectly depressed crude protein levels because of dilution in all grass species that year.

CONCLUSIONS

1. Dry matter and crude protein production were higher for Vernal alfalfa than for the other alfalfa cultivars (Dawson, Fremont, and Team) during the first 3 years of this study. Dawson, however, displayed the most vigor in seedling establishment and persistance in stand maintenance of all alfalfa cultivars. In the legume-grass mixtures, Dawson alfalfa had good compatability with grass species and was superior to Team for stand persistance.

2. Lutana cicer milkvetch in this study started with a poor stand, perhaps due to too low a seeding rate or insufficient seed scarification; however, the milkvetch is rhizomatous and increased to complete ground cover during the first 2 years. This species probably produces higher yields at elevations below 6,200 feet (*11*), as found at the High Plains Grasslands Research Station. Milkvetch grows best at this location from June 15 through August 15 when temperatures are highest. The milkvetch did not initiate growth as early in the spring or as soon after a crop harvest as did alfalfa.

3. Remont sainfoin did not yield as well as Lutana cicer milkvetch nor the alfalfa cultivars. Remont sainfoin should be seeded at a higher rate than was used in this study. It produced best between June 15 through August 15 when seasonal temperatures are highest. This species is subject to winterkill.

4. All of the grass species initiated tillers below the soil surface except Latar orchardgrass, which is above ground. The two bromegrasses, the two wheatgrasses, and Garrison creeping foxtail are rhizomatous and produced a complete ground cover, whereas Fawn tall fescue and meadow foxtail were bunch types. Fawn tall fescue generally produced the highest yields of TDM and crude protein of all the grass species; however, the fescue and the two bromegrasses had inhibited IVDMD during the 1976 growing seasons. Garrison creeping foxtail and Regar bromegrass were stand increasers in the legume-grass mixtures and successfully competed against invading species. Latar orchardgrass had a high percent germination and seedling establishment and was a consistent producer of

nutritious forage during the first two growing seasons. This species made the most rapid regrowth after harvest of all the forage species in the study; however, winterkill was a problem.

5. Simulated intensive or moderate rotation grazing gave about the same yields of TDM and protein, but neither treatment produced as high yields as the hay treatment. The expense of machinery and labor for hay harvest, as opposed to the cost of livestock for grazing, needs to be considered in determining which treatment would produce the greatest returns.

6. A management system involving grazing of the forage for part of the growing season (early or late) and a hay crop could have advantages for some livestock operators. This system could furnish yields of high quality pasture and hay forage and favor stand durability as well. Further study is needed.

7. This study indicated advantages for a legume-grass mixture over those of a single legume species as follows: (1) legume-grass mixtures resist invasion from weedy species more successfully than legumes grown separetly; (2) below ground tillering grasses in the mixture increase the winter hardiness of the mixture of forage species; and (3) legume-grass mixtures tend to stabilize yields and quality of the forage.

8. The most persistent forage stands and consistent high yields of quality forage can be expected from a mixture of Dawson alfalfa with a single grass species of either Garrison creeping foxtail or Regar bromegrass. Latar orchardgrass with Dawson alfalfa has rapid regrowth ability following harvest. If this combination is used, it is advisable to include either Garrison creeping foxtail or Regar bromegrass in the mixture. If winterkill of the orchardgrass should occur, the foxtail or bromegrass will fill in the stand.

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